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Chart 2 shows the comparative ratio of incidence of the disease in the several age groups. The essential difference between this chart and chart 1 is the absence of the distinct peak which appears in the curves for Michigan and Minnesota at the age group "20 to 24 years."

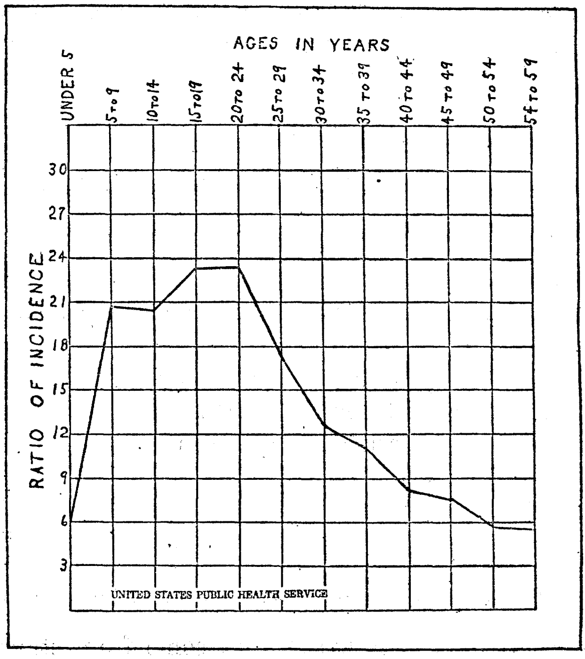

CHART 2.—Ratio of reported cases to population in each 5-year age group.

It is to be borne in mind that the figures and charts are based upon reported cases and that the distribution of such cases may vary to some extent from the distribution of the disease itself. It may be that typhoid fever is more generally recognized (possibly more readily so) between the ages of 5 and 25. It is within the bounds of possibility that the disease may exist to a greater extent than is indicated by the figures here given in other age groups, but not be so frequently recognized. If the disease is overlooked in this way, however, the probabilities are that it is in the age group under 5 years.

MALARIA CONTROL.

DRAINAGE AS AN ANTIMALARIAL MEASURE.

By J. A. A. LE PRINCE, Sanitary Engineer, United States Public Health Service.

Satisfactory drainage as applied to mosquito control is quite different from the usual meaning of the term "drainage." Lands drained for agricultural purposes not infrequently produce mosquito-breeding places.

For mosquito eradication, not only must the land be properly drained, but the drainage ditches must be so planned, constructed, and cared for that they will not become a source or propagating place of mosquitoes.

As a general rule shallow water is more favorable to mosquito production than deep water. A depth of an inch is sufficient; therefore, in order to prevent mosquito breeding we must remove all the water, or make conditions unfavorable.

Drainage.

The mistake is frequently made of constructing ditches chiefly for disposing of storm water, no provision being made for subsequent conditions when the normal water line is reached, which condition may favor mosquito propagation.

Drainage as an antimosquito measure may be discussed under the following heads:

1. Training natural streams and water courses.
2. Open ditches and intercepting ditches.
3. The installation of permanent lining in ditches.
4. Subsurface drains.
5. Filling.
6. Proper maintenance.

Training and Treatment of Small Streams and Natural Water Courses.

Many persons think that mosquitoes come from stagnant water only, but as a matter of fact mosquito larvæ are often found in large numbers in streams having a fairly good current. Of course, along the shallow banks of streams and irregularities in the course of streams where eddies may form, the velocity is markedly decreased. In most streams many places occur where the water is almost, if not absolutely, without current. It is in these places that mosquito propagation is found to occur.

A stream should be made to have steep banks directly above and below the flow line, uniform grade and width, and a straight course, and be free from grass, sticks, stones, or other obstructions that would interfere with the current. These conditions are seldom found in nature, but the nearer a stream approaches them the less will mosquito breeding be found.

Accordingly, we may straighten the course in places when this can be done advantageously, and regrade the bottom in parts, so as to confine the water course within narrow banks and insure an increase of the current even where the amount of water to be drained is low.

There are at times difficulties in effecting proper regrading, particularly at places where streams widen out. This may be overcome by reconstructing a channel with boards or stone and filling in behind it. Sharp bends and places where storm water may scour out and erode the banks may be advantageously treated in this way.

When stone is used the crevices should be filled with small stone and roughly cemented over in order that no pockets or places will remain where water may collect protected against the natural enemies of mosquito larvæ, such as top-minnows, and from the current.

Where the bottom of the ditch is soft, so that there is a tendency to the formation of large pockets in the stream channel, stone may be rammed into place that will prevent further extension of the excavation.

It sometimes happens that soft rock or indurated clay occurs in the bed of a stream. This can be easily cut and a new channel made.

Natural water courses which dry soon after storms frequently have depressions or "pot holes" along their courses, where water may remain and thus produce favorable breeding places for mosquitoes. All such holes should be brought back to grade by filling in with stone so that the water will drain off. The top layer of stone should be well "chinked," tamped, and graded so that water will not remain on it, and be examined after one or two storms to correct any defect that may appear.

Use of Open Ditches or Drains.

There are two principles to be observed in the construction of ditches or drains for antimosquito work:

(*a*) They should be as few as possible.

(*b*) They should have clean-cut, sloping edges, narrow bottoms, and straight courses, if possible.

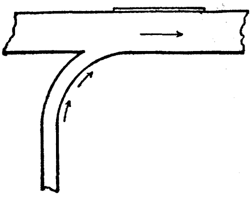

FIG. 1.—Junction of branch ditch and main ditch.

(*a*) The object to be attained must be kept in mind. Where ditching is required for removal of water, the location to be drained, the fall, and direction should be considered in order that there may be as few and short ditches as possible. This will make for a reduction in first cost, and, especially, for maintenance.

Construct the main ditch first, then install the laterals. A few rain showers may indicate where additional ditches are essential. If there is any doubt as to the necessity for cutting some lateral ditch, do not install it.

(*b*) Having determined on the location of the ditches, the lines should be marked by stakes, and a cord used in the field in order that the laborers may dig true to line. Sharp bends should be avoided wherever possible. Branch ditches should join main ditches at an acute angle or curve in order to lessen depositing of silt, sand, and débris at the junction point. (See fig. 1.)

In average soils the slopes of the sides of ditches should be about 45°. In sand and soft mud the slope is flatter, while in hard clay and soft rock it may be almost vertical. In cases where ditches are run across the slope of a ridge the upper side of the ditch must be flatter than the lower side, if there is underground water close to the surface.

For constructing small ditches a tiling spade should be used for finishing off and cutting the bottom. The bottom of a ditch should be made narrow to insure rapid flow. It is more advantageous to have a normal water flow confined within narrow banks and consequently a greater depth of water. This will favor a more rapid current and lessen the possibility of the formation of shallow side pools or pockets.

Where pipe is to be installed in a portion of a ditch, as is the case in constructing a culvert at a road crossing, there the grade of the ditch should be increased; otherwise sedimentation of silt or other materials is likely to take place and cause an obstruction to the current. A screen of vertical rods should be provided at the entrance of such pipe, and at the point of discharge the bottom of the earth ditch should be lined for a distance of about 6 feet with flat stone or lumber, so as to prevent erosion and the formation of a pocket.

Permanent Lining of Ditches.

The lining of ditches is employed in cases where maintenance of open earth ditches is expensive.

Lined ditches are more permanent, easily cleaned, require less inspection, and are ultimately less costly. At some of the settlements in the Panama Canal Zone it was found that a large saving was made by lining certain ditches and parts of ditches with concrete as against repeated regrading, cleaning, and oiling of open earth ditches.

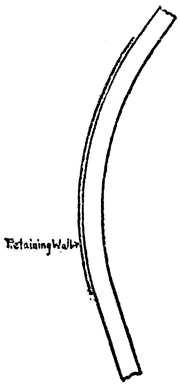

FIG 2.—Retaining wall used at sharp curve of concrete-lined ditch.

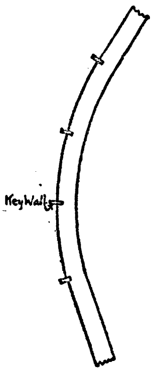

FIG. 3.—Key walls used at outside edge of sharp curve of concrete-lined ditch. To prevent storm water leaving ditch.

The materials which may be used for lining are concrete, stone with cement mortar, or lumber; the two former, of course, being more expensive but more permanent in character.

It is not always necessary to line the entire ditch. The lining of the bottom and sides up to 3 inches above the normal water line for small ditches will answer all purposes. It is not essential that the lining have a smooth or fancy finish, which adds to the cost. A ditch may be roughly lined with flat stone, chinking in the interspaces with small stone and then sealing this roughly with cement mortar.

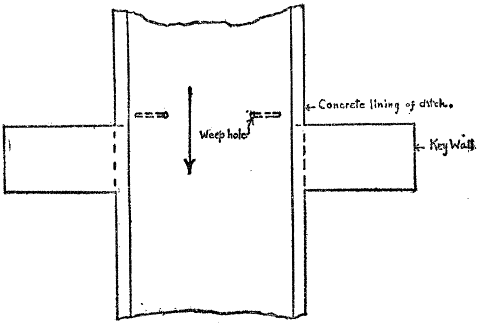

FIG. 4.—Plan of key wall.

Where flat stone is not available, concrete made with gravel or small stone, in a layer of about 2 inches in thickness and reinforced with 2-inch mesh hexagonal poultry wire, may be used.

In order to avoid scouring out of banks above the lining by storm water, particularly at sharp curves or bends of ditches, the outer wall lining should be raised to meet the condition, or the ditch may be widened, or key walls installed. (See figs. 2 and 3.) Key walls are also applicable and will prevent the side scour and under scour of linings of straight ditches of heavy grades. The key wall should extend 6 inches to a foot or more into the ground below the bottom ditch lining. (See figs. 4 and 5.) Branch ditches should enter lined ditches at an acute angle or on a curve with a sharp grade near the junction. (See figs. 1 and 6.) In all cases weep holes, or seepage holes, sloping toward the center or bottom of the ditch and located just above the key wall, should be provided. This is required to prevent the effect of currents which may be under or behind the concrete ditch lining. (See figs. 4 and 5.)

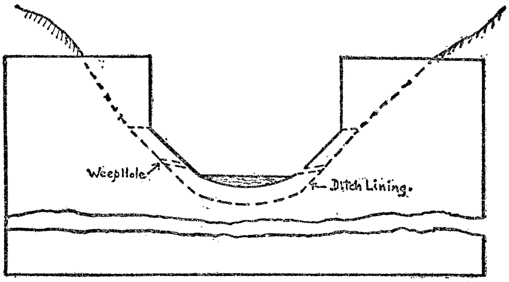

FIG. . .—Cross section of key wall.

Weep holes should be made in side walls before the concrete has set. They should be used wherever water might be behind the lining.

When larger ditches, of 24 inches width or more, are lined, then the side walls should be higher and proportionally thicker.

V-shaped linings are undesirable. As a rule, linings should be U-shaped with sloping sides. (See figs. 5, 6, and 7.)

In wide ditches the bottom should slope toward the center and the side walls may often be almost vertical.

Subsoil Drainage.

Drain tiles are used for this purpose, ranging in size from 3 inches to 12 inches in diameter and in 1 and 2 foot lengths. Such tiling is placed underground, end to end, and covered with earth.

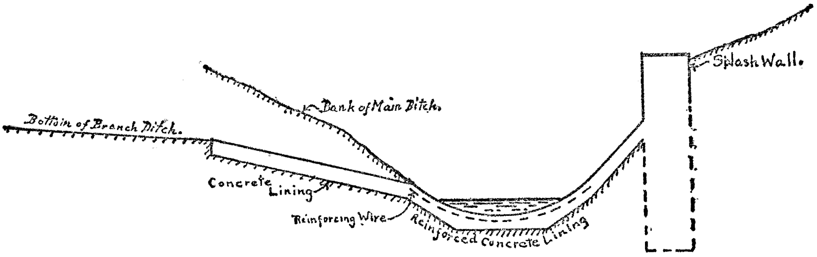

FIG. 6.—Cross section showing junction of concrete-lined ditch and a branch ditch.

Subsurface drainage, in connection with mosquito control, is used for two purposes:

(*a*) To lower the water table or ground water so that pools of surface water will be absorbed more rapidly by the soil.

(*b*) To intercept seepage planes and prevent seepage water from hillsides reaching and collecting on the surface of the ground.

(*a*) Where tiling is used for lowering the water table, the tile lines are located up and down the slope and generally spaced from 50 to 150 feet apart, according to depth, character of soil, and local conditions. When laid within 2 feet of the surface the parallel lines may in some instances have to be as close as 20 feet apart. As a rule, tile laid near the surface drains surface water more rapidly than if laid deeper, but does not drain as large an area.

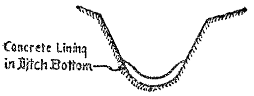

FIG. 7. Concrete lining in ditch bottom.

From 2 to 4 feet is the depth generally used. Very flat grades are permissible if the work is well executed by experienced tile layers, but where grade is available a slope of 12 inches or more per 400 feet is desirable. The tiles are laid in the bottom of a perfectly graded narrow trench, so that the ends abut each other closely, and are then covered with clay or earth. Tile lines discharging into streams or ditches should be so planned as to have the outlet above high water.

This method of drainage is extensively used for agricultural purposes. It aerates the soil, increases its fertility, and removes the water standing on the surface.

(*b*) In using tile drainage for intercepting seepage, a different principle is involved.

Underground water will frequently seep to the surface and form wet areas. These are termed "seepage outcrops," and may be found on hil sides, near the base of hills, and in valleys.

In placing or using tile for intercepting this underground flow of water, the ditch is located above the line of outcrop at time of maximum flow, approximately at right angles to the flow, and given a grade of not less than one-half of 1 per cent or 1 foot in 200 feet. The tile is to be laid with open joints, or about $\frac{1}{8}$ to $\frac{1}{4}$ inch apart, and the trench filled in with such stone as may be available. The layer of stone close to the ground surface should be made of small-sized stone and should extend 2 or 3 inches above the surface. (See figs. 8 and 9.) Branch tile lines should join main line at an acute angle or on a curve. (See figs. 10 and 11.) This form of tile drain is designed to be used only when the lands above it are covered with vegetation.

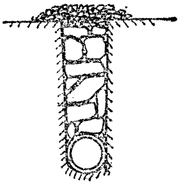
FIG. 8.—Cross section intercepting tile drain.

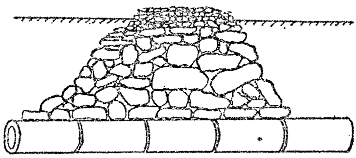
FIG. 9.—Longitudinal section intercepting tile drain.

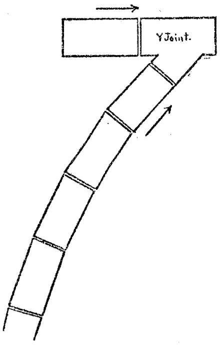

FIG. 10.—Plan of junction of tile lines.

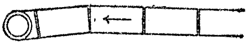
FIG. 11.—Side view. Junction of two tile lines showing "Y joint" and grades.

It is not intended that open ditches, house drains, or waters heavily charged with sediment shall discharge into or on to this type of drain.

All subsurface tiling should, of course, be protected where traffic or roads pass over it.

Inspections should be made to see that the outlets do not become clogged with silt or other form of deposit. Several metal rods placed vertically at the outlet will prevent access of small animals which might die in the tile line. The outlet must be so located that it will at all times discharge freely. (See figs. 12 and 13.)

The advantage of subsurface drain, as compared to the open ditches, is that it is self-cleaning, maintains itself, permits of rapid inspection, needs very little attention, requires no oiling, and permits of no exposure of water accessible to mosquitoes.

Filling.

Collections of water that can not be economically drained should be filled when practicable. This may often be accomplished to advantage by the oiling squad when maintenance work is temporarily reduced. Wet areas that are most expensive to control properly should be eliminated first.

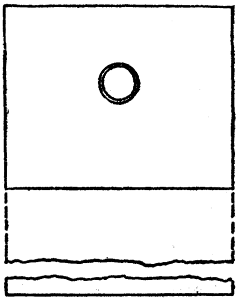

FIG. 12.—Wall at outlet of tile drain.

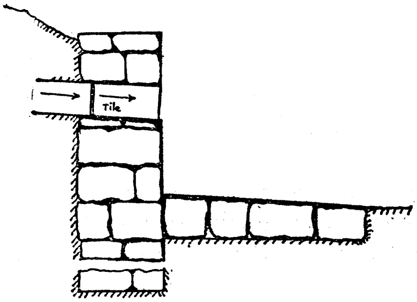

FIG. 13.—Cross section of outlet of tile drain.

Shallow water in areas that are too low to be drained is concentrated by filling, and the remaining body of water is easier to control. Areas kept wet by seepage water can seldom be satisfactorily treated by making a shallow fill of earth.

In making fills with earth or clay, care is taken not to leave depressions on the surface of the fill that may hold water, and the bottoms of "borrow pits" should be made self-draining. Fills made of waste should not be so left that water containers, such as tin cans, etc., are left exposed.

Porous material, such as cinders, are very good for filling ground. In the vicinity of lumber mills, waste, sawdust and shavings are available in quantity, and when used for filling should extend several inches above the surface of the ground.

Maintenance of Ditches.

Ditches that are properly maintained are those which are kept in proper condition and free from mosquito larvæ at the lowest cost.

Due to local topography, character of soil, depth, presence of vegetation, etc., some open ditches or parts thereof may be relatively expensive to maintain.

Obstructions, rough banks which are out of alignment, silting of channels near ditch junctions, vegetation in the ditch or extending into the water from the banks, and algæ, all assist in forming suitable resting or hiding places for mosquito larvæ.

Ditches should be kept to the established grade and of proper cross section, free of obstructions, vegetable growth, and algæ. They should be treated with oil, larvacide, or copper sulphate when and where necessary. Copper sulphate is used for destroying algæ. They should be inspected at proper intervals. The cleaning and grading must be so performed as to interfere as little as possible with the established grade and cross section. The work must be performed with particular care where the ditch is in soft ground.

In dry periods a ditch may become a series of stagnant pools. A small temporary channel may then be made to concentrate and drain off this water. For this purpose a tile spade or hoe is used to advantage. When conditions allow, a channel on a muddy bottom may be rapidly made by dragging a small log or other suitable object downstream in the ditch bed.

Sharp rains will destroy these temporary ditches in soft material and growth of vegetation will become troublesome.

When the banks of streams in pastures are flat and soft both above and below the flow line, hoof-print impressions are made by cattle if not guarded against. The stream should be protected by a fence where necessary. A barrel without bottom may be installed at a place where it will remain filled with water for the stock to drink.

In the spring of each year all ditches and propagation areas should be put in proper condition before the first new crop of mosquitoes appears.

The inspector who is to direct the field work should be carefully selected. He must be relied upon to make frequent and thorough inspection of all parts of ditches, and his judgment is often to be accepted as to the relative importance of work to be done. He must see that all defects are promptly corrected, that work be both thorough and as inexpensive as conditions allow, and that no mosquito larvæ mature. His work is not easy. Unless he is deeply interested in the work his services will be of little value. Much better results may be obtained if the person in charge of the mosquito control shows that the efforts of the inspector are being recognized. It is a part of the inspectors' duty to so train the laborers that they will not make the usual mistakes of excavating below grade, placing excavated material on the high side of ditches, widening ditches, allowing defects to pass unnoticed, etc.

Records of work performed, material expended, etc., should be properly tabulated and kept up to date. Reference to the working map on which all propagation areas are marked and numbered, and to cost-sheet records, will indicate whether any change of method of procedure is advisable and whether or not the work is more costly than is necessary. These records will also enable the health officer in charge to make improvements intelligently.

Campaigns for mosquito control in any locality will generally succeed or fail according to whether or not the person or persons directing the work take the trouble to understand and become interested in the details pertaining to the field work. Much depends upon the frequent and intelligent inspection of the work as actually being done in the field. Some mosquito-control work has been undertaken which would have been far more successful if those directing the work had spent more time out in the field where the work was thought to be progressing satisfactorily. The officers who direct mosquito control, in considering costs must keep in mind the unit and total cost of the work during a long or definite period of time and not think only of the present season.

RAT PROOFING THE PUBLIC DOCKS OF NEW ORLEANS.

A REPORT ON ITS POSSIBILITY AND COST.

By H. P. LETTON, Sanitary Engineer, United States Public Health Service.

The State of Louisiana has taken over practically the entire river front of New Orleans for the good of the general public. The control of this property is vested in the Board of Commissioners of the Port of New Orleans, popularly known as the Dock Board. This board has very extensive powers. It may issue bonds for the construction and operation of warehouses, wharves, and landings, may expropriate property, and in short may take any practical and necessary step for increasing the efficiency and economy of the port's facilities. The board is appointed by the governor and serves without pay.

The public wharves extend from Louisiana Avenue to Pauline Street, their total length being 4.82 miles. They are continuous except for ferry landings at Esplanade Avenue, Canal Street, Terpsichore Street and Jackson Avenue, these breaks aggregating 0.30 miles. In about three-fourths of their length the wharves are covered by steel sheds, which have an aggregate length of 3.77 miles. These sheds rest either wholly on the wharf proper or partly on the wharf and partly on the land back of the wharf. Above Louisiana Avenue and extending to Napoleon Avenue, a distance of about a mile, are the Stuyvesant Docks owned by the Illinois Central Railroad. These docks are discussed in a separate report. Above Napoleon Avenue there are being constructed a reinforced concrete wharf